

National Aeronautics and Space Administration



## OFFICE OF THE CHIEF TECHNOLOGIST

# SPACE TECHNOLOGY RESEARCH FELLOWSHIPS

**Presentation at the NASA Advisory Council Technology and Innovation Committee Meeting**

**November 18, 2011**

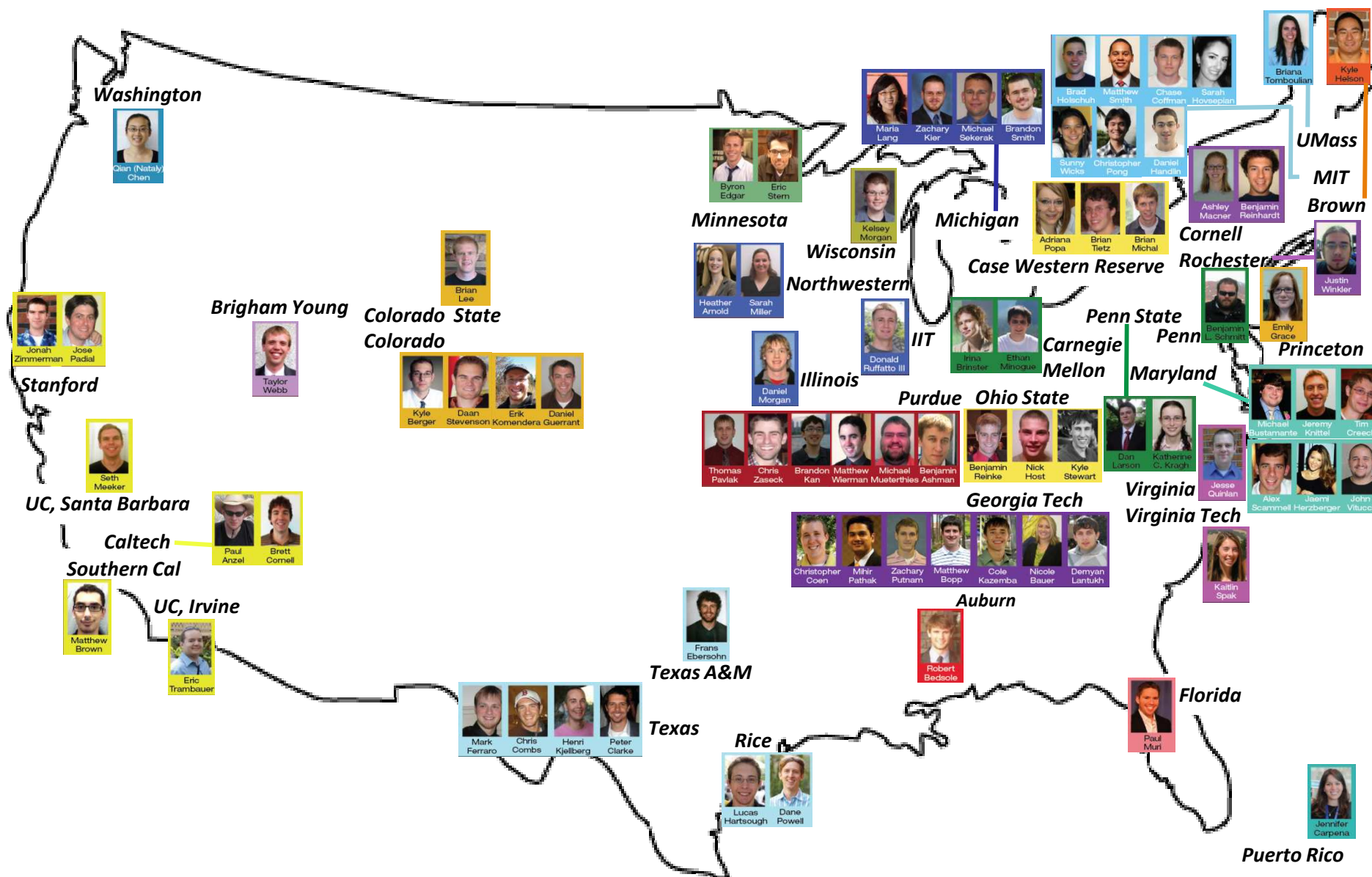
**Claudia Meyer**  
**Space Technology Research Grants Program Executive**

[www.nasa.gov](http://www.nasa.gov)

# National Asset: The Inaugural Class of NSTRF



80 Students - 37 Universities - 22 States and U.S. Territories



# NSTRF Core Values



**“NASA Space Technology Fellows will perform innovative space technology research while building the skills necessary to become future technological leaders.”**

*July 27, 2011*

*RELEASE : 11-246*

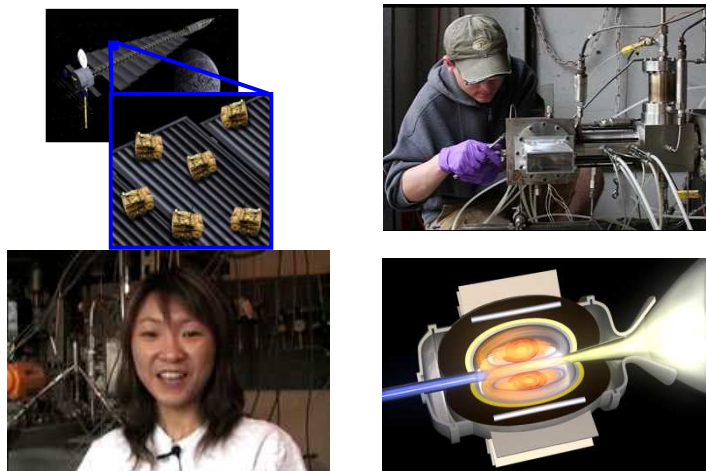
*NASA Awards Space Technology Research Fellowship Grants*

[http://www.nasa.gov/home/hqnews/2011/jul/HQ\\_11-246\\_STRF\\_Awards.html](http://www.nasa.gov/home/hqnews/2011/jul/HQ_11-246_STRF_Awards.html)

# Space Technology Research Grants - Program Overview



## Level II Program Office: GRC



**Objective:** Accelerate the development of push technologies through innovative efforts with high risk/high payoff

- **Early Stage Innovation -Space Technology Research Opportunities (ESI-STRO):** Low TRL technology portfolio for groundbreaking research in advanced space technology
- **NASA Space Technology Research Fellowships (NSTRF):** Competitive selection of U.S Citizen / permanent resident graduate students developing promising technologies in support of future NASA missions and strategic goals

## Acquisition Strategy

- **ESI-STRO:** NRA solicitation expected annually. Awards are grants, cooperative agreements, contracts or intra-agency transfers.
- **NSTRF:** Annual solicitation consistent with academic calendar. Awards are training grants to accredited U.S. universities. Selected candidates perform graduate student research on their respective campuses, at NASA Centers and not-for-profit Research and Development (R&D) labs.

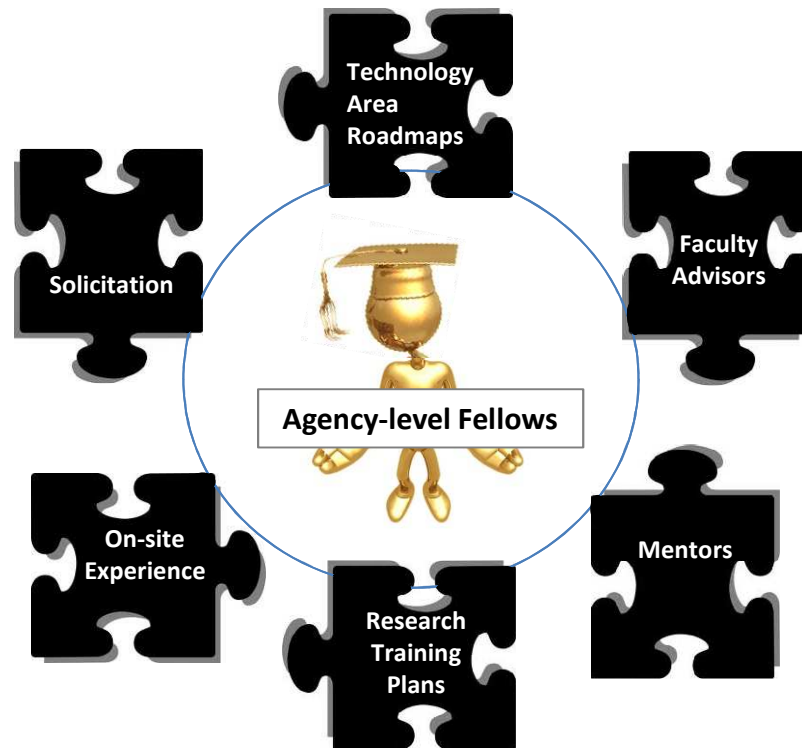
## Awards

- **ESI-STRO:** Typical 12 months awards at \$250K. 100+ per year.
- **NSTRF:** 80 Fellows in inaugural year. NSTRF12 released on 11-4-11

## Collaboration

- **ESI-STRO:** Proposals welcome from all sources, including academia, industry, all U.S. government agencies and non-profit organizations; teaming encouraged
- **NSTRF:** Each student is matched with a professional advisor at NASA Centers or R&D Lab

# The “Pieces” of the NASA Space Technology Research Fellowships



# The Solicitation - *Introduction*



## NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIPS (NSTRF) - Fall 2012 Fellowship Start

|   |                                   |
|---|-----------------------------------|
| Call for applications.....              | November 4, 2011                  |
| Applications due.....                   | January 11, 2012 at<br>6:00 PM ET |
| Fellowship selection notifications..... | Late April 2012 (target)          |
| Fellowship acceptance deadline.....     | Notification + 7 days             |
| Start date of fellowships.....          | August 1, 2012 (target)           |

*The solicitation is available by*

- opening the NASA Research Opportunities homepage at <http://nspires.nasaprs.com/>,
- selecting "Solicitations,"
- then selecting "Open Solicitations," and,
- finally, selecting "NSTRF12."

## Minimum Eligibility Requirements for NSTRF12

1. Pursuing or seeking to pursue advanced STEM degrees.
2. U.S. citizens or permanent residents of the U.S.
3. Have or will have a Bachelor's degree prior to the fall of 2012.
4. Are or will be enrolled in a full-time Master's or Doctoral degree program at an accredited U.S. university in fall 2012 (awards may not be deferred).
5. Have completed no more than twenty-four months of full-time graduate study as of August 1, 2011. Full-time graduate study is as defined by the universities attended. Applicants who have completed part-time graduate study must have completed no more than 30 semester hours or 45 quarter hours, or their equivalent, as of August 1, 2011; this credit hour limit applies to part-time graduate students.

NSTRF<sup>11</sup> (inaugural year) documents are available  
at <http://tinyurl.com/NSTRF11-OCT>.

# The Solicitation – *Application Components*



*The student shall be the principal author of the Educational Research Area of Inquiry and Goals, with minimal assistance from the current/prospective faculty advisor.*

1

## **Educational Research Area of Inquiry and Goals**

- summary of educational program objectives
- research interests with associated relevant hypotheses and possible approaches
- benefits of proposed research
- benefits of on-site R&D lab experience



2

## **Schedule of degree program**

- proposed start and completion dates
- anticipated milestones

4

## **Statement from faculty advisor (one page)**

- planned use of faculty advisor allowance
- If applicable, brief description of ongoing or pending research awards from NASA that are related to the student's Educational Research Area of Inquiry and Goals.

6

## **Transcripts**

- undergraduate
- graduate

3

## **Curriculum Vitae (one page)**

- faculty advisor
- student

5

## **Three signed letters of recommendation**

- from academic advisor
- from other faculty members or professionals with detailed knowledge of student's abilities

7

## **GRE general test scores**

# The Solicitation - Basis for Inspiration



## TA01 • LAUNCH SYSTEMS

**SOLID ROCKET PROPULSION SYSTEMS**

- Propellants
- Case Materials
- Nozzle Systems
- Hybrid Rocket Propulsion Systems
- Fundamental Solid Propulsion Technologies

## TA02 • IN-SPACE PROPULSION TECHNOLOGIES

**LIQUID ROCKET PROPULSION SYSTEMS**

- LH<sub>2</sub>/LOX Based
- RP/LOX Based
- CH<sub>4</sub>/LOX Based
- Detonation Wave Engines (Closed Cycle)
- Propellants
- Fundamental Liquid Propulsion Technologies

## TA03 • SPACE POWER & ENERGY STORAGE

**AIR BREATHING PROPULSION SYSTEMS**

- TBCC
- RBCC
- Detonation Wave Engines (Open Cycle)
- Turbine Based Jet Engines (Flyback Boosters)
- Ramjet/Scramjet Engines (Accelerators)
- Deeply-cooled Air Cycles
- Air Collection & Enrichment System
- Fundamental Air Breathing Propulsion Technologies

## TA04 • ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS

**ANCILLARY PROPULSION SYSTEMS**

- Auxiliary Control Systems
- Main Propulsion Systems (Excluding Engines)
- Launch Abort Systems
- Thrust Vector Control Systems
- Health Management & Sensors
- Pyro & Separation Systems
- Fundamental Ancillary Propulsion Technologies

## TA05 • COMMUNICATION & NAVIGATION

**UNCONVENTIONAL / OTHER PROPULSION SYSTEMS**

- Ground Launch Assist
- Air Launch / Drop Systems
- Space Tether Assist
- Beamed Energy / Energy Addition
- Nuclear
- High Energy Density Materials/Propellants

## TA06 • HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS

**CHEMICAL PROPULSION**

- Liquid Storable
- Liquid Cryogenic
- Gels
- Solid
- Hybrid
- Cold Gas/Warm Gas
- Micro-propulsion

## TA07 • HUMAN EXPLORATION DESTINATION SYSTEMS

**NON-CHEMICAL PROPULSION**

- Electric Propulsion
- Solar Sail Propulsion
- Thermal Propulsion
- Tether Propulsion

## TA08 • SCIENCE OBSERVATORIES & SENSOR SYSTEMS

**ADVANCED (TRL <3) PROPULSION TECHNOLOGIES**

- Beamed Energy Propulsion
- Electric Sail Propulsion
- Fusion Propulsion
- High Energy Density Materials
- Antimatter Propulsion
- Advanced Fission
- Breakthrough Propulsion

## TA09 • ENTRY, DESCENT & LANDING SYSTEMS

**SUPPORTING TECHNOLOGIES**

- Engine Health Monitoring & Safety
- Propellant Storage & Transfer
- Materials & Manufacturing Technologies
- Heat Rejection
- Power

## TA10 • NANOTECHNOLOGY

**POWER GENERATION**

- Energy Harvesting
- Chemical (Fuel Cells, Heat Engines)
- Solar (Photo-Voltaic & Thermal)
- Radioisotope
- Fission
- Fusion

## TA11 • MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING

**ENERGY STORAGE**

- Batteries
- Flywheels
- Regenerative Fuel Cells

## TA12 • MATERIALS, STRUCTURES, MECHANICAL SYSTEMS & MANUFACTURING

**POWER MANAGEMENT & DISTRIBUTION**

- FDIR
- Management & Control
- Distribution & Transmission
- Wireless Power Transmission
- Conversion & Regulation

## TA13 • GROUND & LAUNCH SYSTEMS PROCESSING

**CROSS CUTTING TECHNOLOGY**

- Analytical Tools
- Green Energy Impact
- Multi-functional Structures
- Alternative Fuels

## TA14 • THERMAL MANAGEMENT SYSTEMS

**ENVIRONMENTAL CONTROL & LIFE SUPPORT SYSTEMS & HABITATION SYS.**

- Air Revitalization
- Water Recovery & Management
- Waste Management
- Habitation

## TA15 • CRYOGENIC SYSTEMS

**EXTRAVEHICULAR ACTIVITY SYSTEMS**

- Pressure Garment
- Portable Life Support System
- Power, Avionics and Software

## TA16 • AUTON. RENDEZVOUS & DOCKING

**HUMAN HEALTH & PERFORMANCE**

- Medical Diagnosis / Prognosis
- Long-Duration Health
- Behavioral Health & Performance
- Human Factors & Performance

## TA17 • ENVIRONMENTAL MONITORING, SAFETY & EMERGENCY RESPONSE

**ENVIRONMENTAL CONTROL & LIFE SUPPORT SYSTEMS & HABITATION SYS.**

- Air Revitalization
- Water Recovery & Management
- Waste Management
- Habitation

## TA18 • OPTICAL COMM. & NAVIGATION

**OPTICAL COMM. & NAVIGATION**

- Detector Development
- Large Apertures
- Lasers
- Acquisition & Tracking
- Atmospheric Mitigation

## TA19 • RADIO FREQUENCY COMMUNICATIONS

**RADIO FREQUENCY COMMUNICATIONS**

- Spectrum Efficient Technologies
- Power Efficient Technologies
- Propagation
- Flight & Ground Systems
- Earth Launch & Reentry Comm.
- Antennas

## TA20 • SUSTAINABILITY & SUPPORTABILITY

**INTERNETWORKING**

- Disruptive Tolerant Networking
- Adaptive Network Topology
- Information Assurance
- Integrated Network Management

## TA21 • POSITION, NAVIGATION, AND TIMING

**INTEGRATED TECHNOLOGIES**

- Radio Systems
- Ultra Wideband
- Cognitive Networks
- Science from the Comm. System
- Hybrid Optical Comm. & Nav. Systems
- RF/Optical Hybrid Technology

## TA22 • CROSS-CUTTING SYSTEMS

**MISSION OPERATIONS & SAFETY**

- Crew Training
- Environmental Protection
- Remote Mission Operations
- Planetary Safety

## TA23 • REMOTE SENSING INSTRUMENTS / SENSORS

**IN-SITU INSTRUMENTS / SENSOR**

- Detectors & Focal Planes
- Electronics
- Optical Components
- Microwave / Radio
- Lasers
- Cryogenic / Thermal

## TA24 • OBSERVATORIES & SENSOR SYSTEMS

**REMOTE SENSING INSTRUMENTS / SENSORS**

- Detectors & Focal Planes
- Electronics
- Optical Components
- Microwave / Radio
- Lasers
- Cryogenic / Thermal

## TA25 • IN-SITU INSTRUMENTS / SENSOR

**IN-SITU INSTRUMENTS / SENSOR**

- Particles: Charged & Neutral
- Fields & Waves
- In-Situ

## TA26 • RADIATION

**RADIATION**

- Risk Assessment Modeling
- Radiation Mitigation
- Protection Systems
- Space Weather Prediction
- Monitoring Technology

## TA27 • AEROSASSIST & ATMOSPHERIC ENTRY

**AEROSASSIST & ATMOSPHERIC ENTRY**

- Rigid Thermal Protection Systems
- Flexible Thermal Protection Systems
- Rigid Hypersonic Decelerators
- Deployable Hypersonic Decelerators
- Instrumentation & Health Monitoring
- Entry Modeling & Simulation

## TA28 • DESCENT

**DESCENT**

- Attached Deployable Decelerators
- Trailing Deployable Decelerators
- Supersonic Retropropulsion
- GN&C Sensors
- Descent Modeling & Simulation

## TA29 • LANDING

**LANDING**

- Touchdown Systems
- Egress & Deployment Systems
- Propulsion Systems
- Large Body GN&C
- Small Body Systems
- Landing Modeling & Simulation

## TA30 • VEHICLE SYSTEMS TECHNOLOGY

**VEHICLE SYSTEMS TECHNOLOGY**

- Architecture Analyses
- Separation Systems
- System Integration & Analyses
- Atmosphere & Surface Characterization

## TA31 • ENGINEERED MATERIALS & STRUCTURES

**ENGINEERED MATERIALS & STRUCTURES**

- Lightweight Structures
- Damage Tolerant Systems
- Coatings
- Adhesives
- Thermal Protection & Control

## TA32 • ENERGY GENERATION & STORAGE

**ENERGY GENERATION & STORAGE**

- Energy Storage
- Energy Generation

## TA33 • PROPULSION

**PROPULSION**

- Propellants
- Propulsion Components
- In-Space Propulsion

## TA34 • SENSORS, ELECTRONICS & DEVICES

**SENSORS, ELECTRONICS & DEVICES**

- Sensors & Actuators
- Nanoelectronics
- Miniature Instruments

## TA35 • MATERIALS

**MATERIALS**

- Lightweight Structure
- Computational Design
- Flexible Material Systems
- Environment
- Special Materials

## TA36 • STRUCTURES

**STRUCTURES**

- Lightweight Concepts
- Design & Certification Methods
- Reliability & Sustainment
- Test Tools & Methods
- Innovative, Multifunctional Concepts

## TA37 • MECHANICAL SYSTEMS

**MECHANICAL SYSTEMS**

- Deployables, Docking and Interfaces
- Mechanism Life Extension Systems
- Electro-mechanical, Mechanical & Micromechanisms
- Design & Analysis Tools and Methods
- Reliability / Life Assessment / Health Monitoring
- Certification Methods

## TA38 • MANUFACTURING

**MANUFACTURING**

- Manufacturing Processes
- Intelligent Integrated Manufacturing and Cyber Physical Systems
- Electronics & Optics Manufacturing Process
- Sustainable Manufacturing

## TA39 • CROSS-CUTTING

**CROSS-CUTTING**

- Nondestructive Evaluation & Sensors
- Model-Based Certification & Sustainment Methods
- Loads and Environments

## TA40 • TECHNOLOGIES TO OPTIMIZE THE OPERATIONAL LIFE-CYCLE

**TECHNOLOGIES TO OPTIMIZE THE OPERATIONAL LIFE-CYCLE**

- Storage, Distribution & Conservation of Fluids
- Automated Alignment, Coupling, & Assembly Systems
- Autonomous Command & Control for Ground and Integrated Vehicle/Ground Systems

## TA41 • ENVIRONMENTAL AND GREEN TECHNOLOGIES

**ENVIRONMENTAL AND GREEN TECHNOLOGIES**

- Corrosion Prevention, Detection, & Mitigation
- Environmental Remediation & Site Restoration
- Preservation of Natural Ecosystems
- Alternate Energy Prototypes

## TA42 • TECHNOLOGIES TO INCREASE RELIABILITY AND MISSION AVAILABILITY

**TECHNOLOGIES TO INCREASE RELIABILITY AND MISSION AVAILABILITY**

- Advanced Launch Technologies
- Environment-Hardened Materials and Structures
- Inspection, Anomaly Detection & Identification
- Fault Isolation and Diagnostics
- Prognostics Technologies
- Repair, Mitigation, and Recovery Technologies
- Communications, Networking, Timing & Telemetry

## TA43 • TECHNOLOGIES TO IMPROVE MISSION SAFETY/MISSION RISK

**TECHNOLOGIES TO IMPROVE MISSION SAFETY/MISSION RISK**

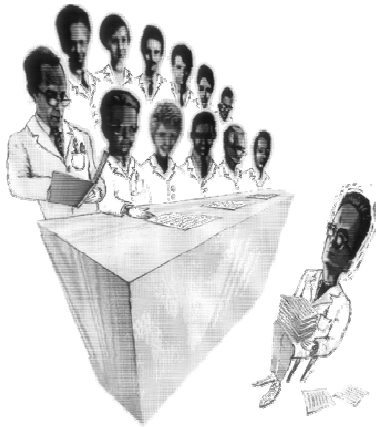
- Range Tracking, Surveillance & Flight Safety Technologies
- Landing & Recovery Systems & Components
- Weather Prediction and Mitigation
- Robotics / Telerobotics
- Safety Systems

# Space Technology Roadmaps STR • TABS TECHNOLOGY AREA BREAKDOWN STRUCTURE

# The Solicitation – *Application Evaluation and Selection*



*All eligible fellowship applications will undergo a review by technical experts.*



## Criteria for Evaluation

### **Merit** of the Applicant's Proposed Educational Research Area of Inquiry and Goals

- technical merit as appropriate to the candidate's educational level
- research area description, knowledge of relevant research literature and plans for student/advisor/mentor partnership

### **Relevance** of the proposed research to NASA's Space Technology Roadmaps

### **Academic excellence and Potential**

- Organizational and analytical skills
- scientific curiosity, creativity, acumen, and success in research appropriate to his/her educational level

**NOTE:** Subsequent to the technical review, candidates deemed excellent will be submitted to the Office of the Chief Technologist at NASA Headquarters for final consideration and selection.



# Annual Award Values



| Category   | Maximum value * |
|--|-----------------|
| Student Stipend                                  | \$36,000        |
| Faculty Advisor Allowance                        | \$9,000         |
| On-site NASA Center/R&D lab experience Allowance | \$10,000        |
| Health Insurance Allowance                       | \$1,000         |
| Tuition and Fees Allowance                       | \$10,000        |
| <b>TOTAL</b>                                     | <b>\$66,000</b> |

*\* from NSTRF12 solicitation*

- A fellowship award is issued as a training grant to the student's host university.
- Separate from the awards, the Program has allocated resources to cover mentor time and costs associated with hosting/interacting with the Fellow.

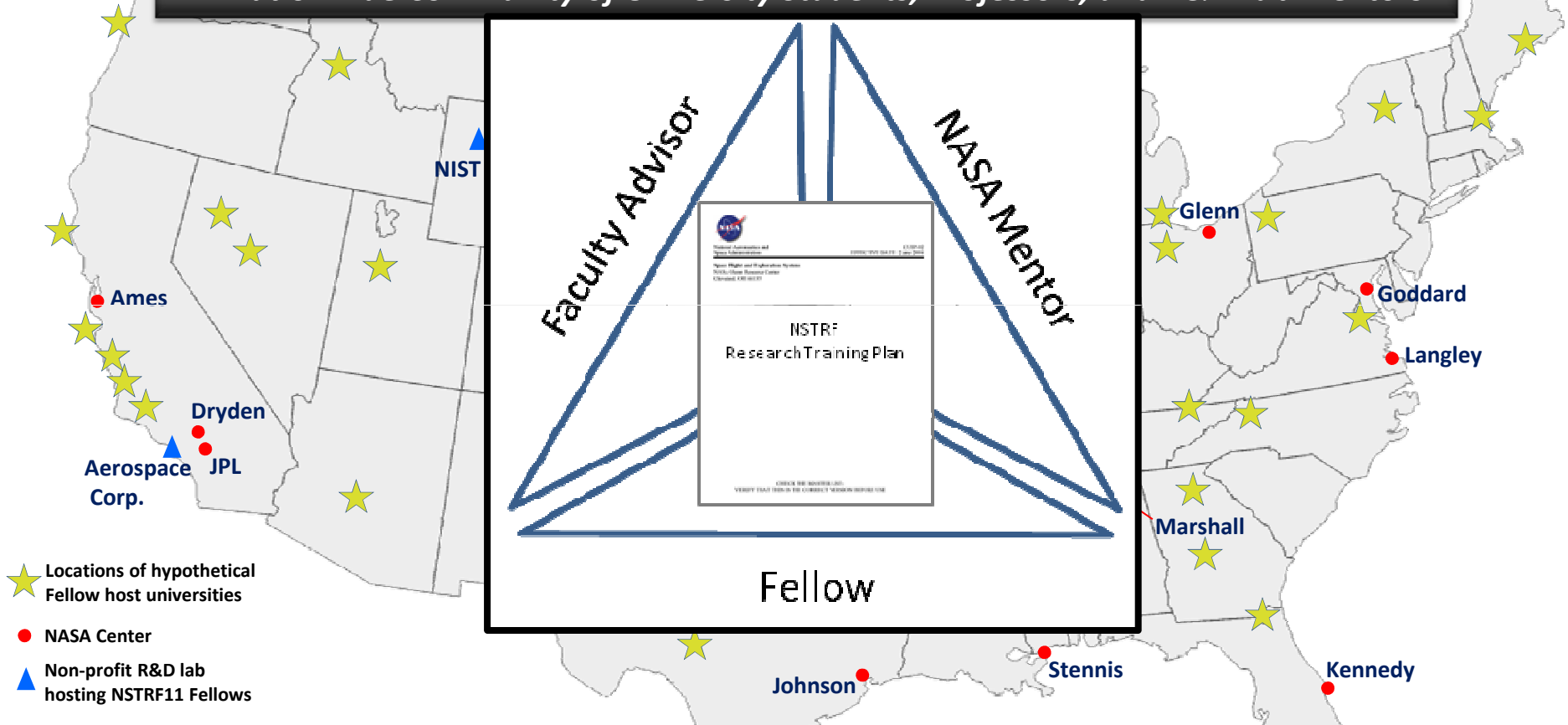


# **Completing the Vision: Mentors**

*Lining the future space technology  
stars up with the best mentors...*



## Space Technology Research Fellowships: A Nationwide Community of University Students, Professors, and R&D Lab Mentors



# Tying it All Together: Research Training Plan



| NSTRF Research Training Plan for<br>NASA Grant #NNX0000000 |                           |
|--|---------------------------|
| Title  |                           |
| University Name  |                           |
| Space Technology Fellow                                    | First Last                |
| Academic Advisor (PI)                                      | First Last                |
| Mentor   | First Last<br>NASA Center |

## Key Elements of Research Training Plan

- Cover page (including Abstract)
- Research Description
  - Introduction
  - Goal
  - Background
  - Approach/Methodology
  - Expected Outcome(s)
  - References
- **Relevance to NASA**
- On-site Experience(s)
- Conferences
- Schedule

| Nanotechnology Team Members |   |
|-----------------------------|---|
| • ARC                       | <ul style="list-style-type: none"> <li>-- Dr. Vadim Smelyanskiy</li> <li>-- Dr. Jing Li</li> </ul>  |
| • GRC                       | <ul style="list-style-type: none"> <li>-- Dr. Marisabel Lebron Colon</li> <li>-- Dr. Sandi Miller</li> <li>-- Dr. Tiffany Williams</li> <li>-- Dr. Francisco Sola Lopez</li> </ul>            |
| • GSFC                      | <ul style="list-style-type: none"> <li>-- Dr. Ted Swanson</li> </ul>  |
| • JPL                       | <ul style="list-style-type: none"> <li>-- Dr. Harish Manohara</li> </ul>  |
| • LaRC                      | <ul style="list-style-type: none"> <li>-- Dr. Emilie Stochi</li> <li>-- Dr. Kris Wise</li> </ul>  |
| • Others                    | <ul style="list-style-type: none"> <li>-- Nanocomp</li> <li>-- Lockheed Martin</li> <li>-- MIT -- Brian Wardle -- collaboration through STRFs</li> <li>-- Other universities - TBD</li> </ul> |

Example (from Game Changing Program Briefing) of how NSTRF advisors and students might appear as team members on NASA projects.

***This section is expected to have significant input from the mentor in identifying and elaborating on the ties to not just the Technology Areas and Grand Challenges, but also documenting relevance to on-going activities in NASA's Mission Directorates.***

## Research Training Plan: Required by a NASA Space Technology Research Fellowship (NSTRF)

### Purpose:

Will be used by the Program for both internal (to NASA) and external reporting and advocacy.

Sharing portions of these plans fosters an awareness of the variety of activities that are being sponsored within each technology area.

## Instructions and Considerations

- ❑ Should be developed collaboratively by the student Fellow, Academic Advisor, and NASA mentor.
- ❑ Should be based on the original proposal.
- ❑ Intended to tie the student's research being performed on campus, as part of his/her degree program, with the research to be conducted at the NASA Center or R&D lab.
- ❑ Submitted (by student) before end of the fall academic term.

# NSTRF11 Results

## NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIPS (NSTRF) - Fall 2011 Fellowship Start

|                                      |                                     |
|--------------------------------------|-------------------------------------|
| Call for proposals.....              | December 29, 2010                   |
| Proposals due.....                   | February 23, 2011 at<br>11:59 PM ET |
| Announcement of new fellowships..... | May 18, 2011 (target)               |
| Fellowship acceptance deadline.....  | May 27, 2011 (target)               |
| Start date of fellowships.....       | August 1, 2011 (target)             |

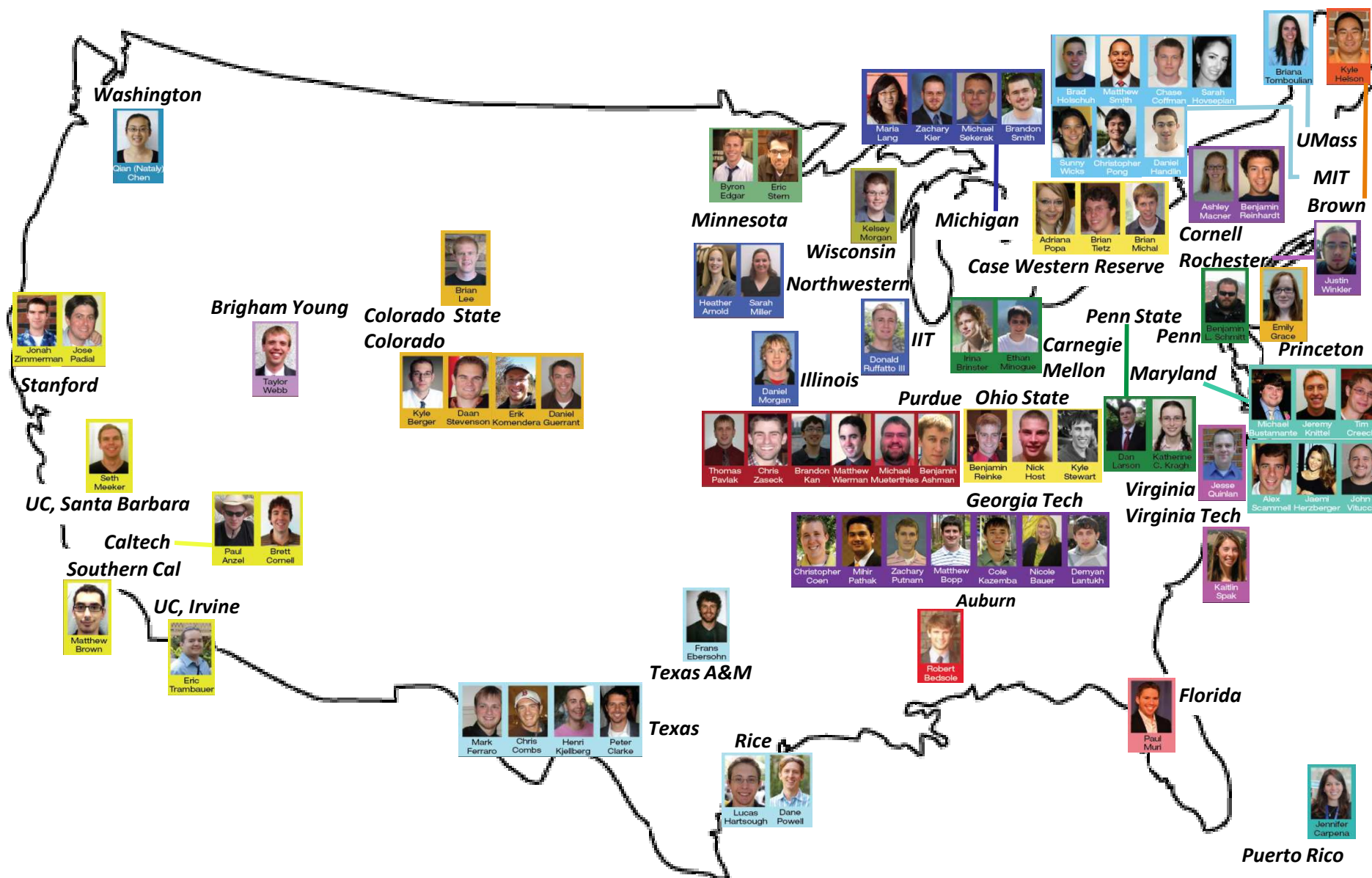
<http://tinyurl.com/NSTRF11-OCT>

*Inaugural call cover page*

# National Asset: The Inaugural Class of NSTRF



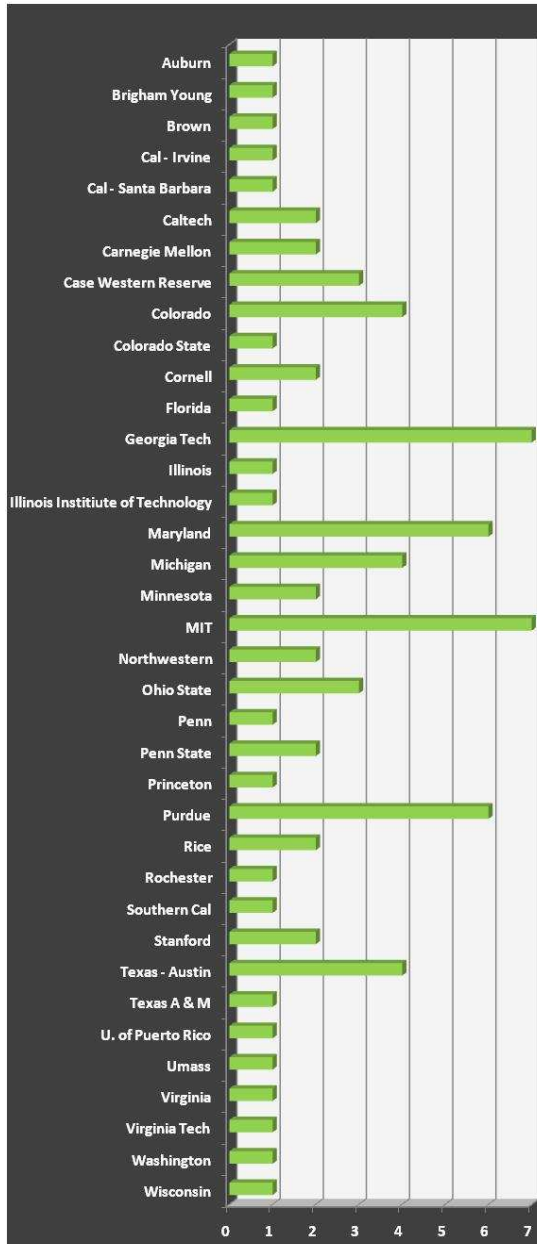
80 Students - 37 Universities - 22 States and U.S. Territories



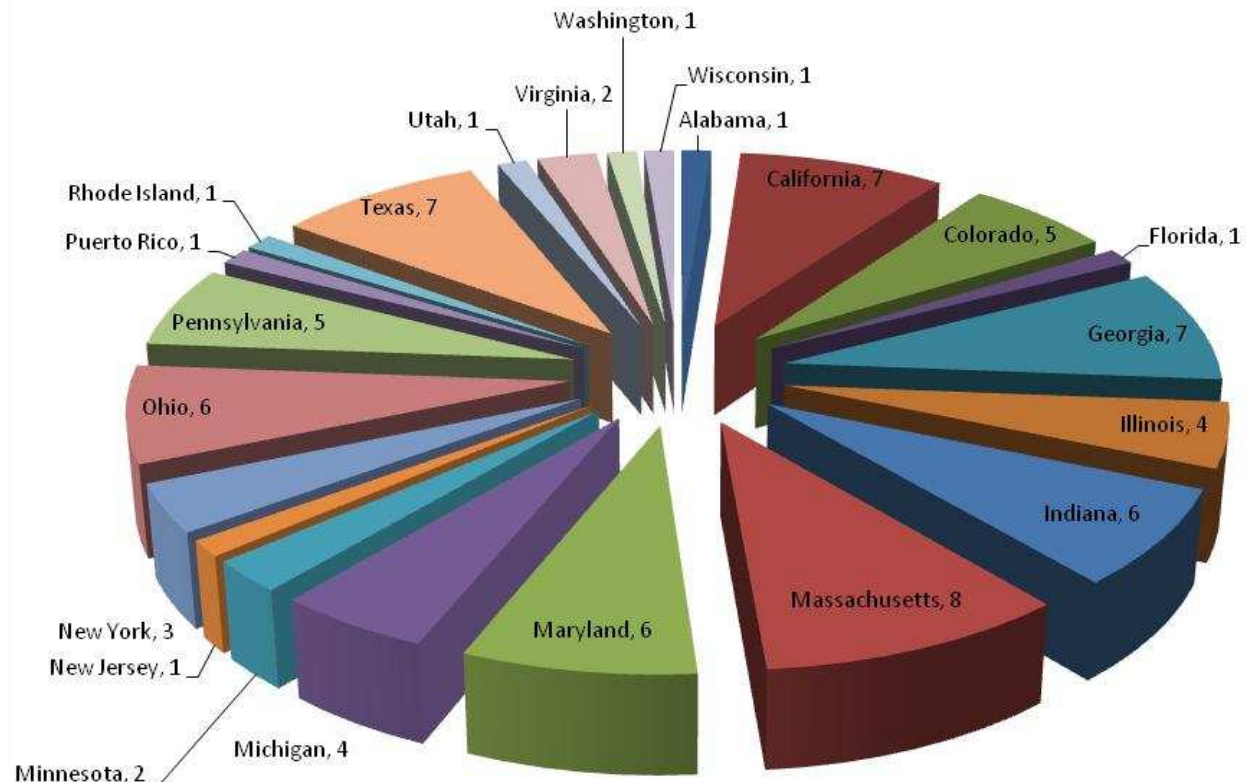
# NSTRF11 Awards by University and State



Number of Awards by University



Number of Awards by State





17

# Find Out More About the NSTRF11 Awards



2011 Inaugural Class - Windows Internet Explorer

innovation/grants/2011\_inaugural\_class.html

NASA Home > Offices > OCT > Early Stage Innovation > Grants

Office of the Chief Technologist

Text Size + - Tweet 4 Like 113

NASA Space Technology Research Fellows - 2011 Inaugural Class

View the NASA Press Release

| Student                 | Host University                    | Research Topic  |
|-------------------------|------------------------------------|---|
| Anzel, Paul             | California Institute of Technology | Development of Nonlinear Phased Array Systems for Non-Destructive Evaluation and Structural Health Monitoring of Aerospace Structures |
| Arnold, Heather         | Northwestern University            | Excitonics based on carbon nanomaterials: A pathway toward low-power, high-speed, and radiation-hard computation                      |
| Ashman, Benjamin Wesley | Purdue University                  | Incorporation of GNSS Multipath to Improve Autonomous Rendezvous, Docking and Proximity Operations in Space                           |
| Bauer, Nicole Christine | Georgia Institute of Technology    | Small Probes for Orbital Return of Experiments Mission Design   |
| Bedsole, Robert         | Auburn University                  | Characterization and modeling of high-strain rate failure response of nanocomposites  |
| Berger, Kyle            | University of Colorado, Boulder    | Prediction of Regolith Ejection during Extraterrestrial Landings  |
| Bopp, Matthew           | Georgia Institute of Technology    | Implementation and Assessment of a Time-Accurate Aeroelastic Model for Analysis of Inflatable Aerodynamic Decelerators                |
| Brinster, Irina         | Carnegie Mellon University         | Mission Trade Space Evaluation through Multiphysics Design and Optimization   |
| Brown, Matthew          | University of Southern California  | Task allocation using continuous resource distributed markov decision processes   |
| Bustamante, Michael     | University of Maryland             | Burning Rate Emulator Experiments for Spacecraft Fire   |




Text Size + - Tweet 0 Like

## Development of Nonlinear Phased Array Systems for Non-Destructive Evaluation and Structural Health Monitoring of Aerospace Structures

Paul Anzel  
California Institute of Technology

Acoustic imaging has played an essential role in ensuring that structures and vehicles are in sound condition both during their construction and their operation. Our lab has developed a new sound focusing system: a phased array (colloquially referred to as an "acoustic lens") based upon wave transmission through adjustable non-linear media. For my research, I will develop a prototype of this system and explore its potential for imaging.



The lens is built from parallel chains of metallic spheres. These chains support the transmission of compact single wave pulses, and by pre-compressing a chain we can modify the signal speed within it. If the chains are differentially compressed and coupled with a linear medium, it is possible to time the transmission of a pulse so that the response it generates in the linear medium coalesces to a small volume, generating a "sound bullet." This device offers a unique combination of advantages over current techniques for acoustic imaging as it is capable of dynamically changing its focal point, it is able to support the creation of a single transient pulse (simplifying the task of signal analysis and possibly allowing for a more accurate result), and it is capable of supporting a powerful signal.

To develop the lens for practical use, three major issues will be addressed in order to determine the boundaries of its performance. First, the limits of where the signal can be focused will be studied. Second, methods to improve transmission of the signal to the linear system will be explored. And third, the limitations of signal power and the degradation of performance due to plastic deformation of the spheres will be determined.

With these issues addressed, I will construct a prototype of the lens. Once the prototype has been built research will then shift towards applying the lens to imaging. I will first test the ability of the lens to image features within bulk media and then

*Developing the technological foundation for NASA's future science and exploration missions...providing the nation with a pipeline of highly skilled engineers and technologists to improve U.S. competitiveness.*

The full listing of NSTRF11 awarded proposals with abstracts is available on the NASA OCT website at [http://www.nasa.gov/offices/oct/early\\_stage\\_innovation/grants/2011\\_inaugural\\_class.html](http://www.nasa.gov/offices/oct/early_stage_innovation/grants/2011_inaugural_class.html)

# Summary



- Inaugural class is in place – *impressive credentials*
- Roadmaps are the basis for collaboration
- Research partnerships are being formed
- NSTRF12 solicitation is open – we look forward to welcoming the next class of Space Technology Research Fellows

